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THE ANOMALIES OF THE OCULAR
MUSCLES

SECOND PAPER

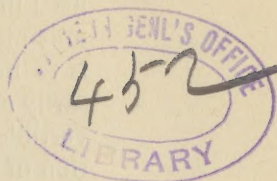
BY

DR. GEO. T. STEVENS, NEW YORK



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THE ANOMALIES OF THE OCULAR MUSCLES.

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SECOND PAPER.

III.—DIFFERENTIAL CHARACTERISTICS OF HETEROPHORIA AND STRABISMUS.

IN order to arrive at a clear and exact understanding of the nature, importance, and management of the condition to be discussed in this paper we are to keep strictly in mind the difference between heterophoria and strabismus. To this end we may with advantage recall what has already been stated in the preceding paper in respect to the differential characteristics of the two conditions.

In the first of the two classes, heterophoria, binocular vision is habitually maintained but by the expenditure of a greater amount of force than is demanded in the perfect equilibrium of the ocular muscles. In the second class, strabismus, there is habitual diplopia, conscious or unconscious. It is true that, in certain cases of strabismus, fusion of images is possible for brief periods of time and under favorable circumstances, and it is also true that in conditions of heterophoria the tension upon the adjusting muscles is not always exercised to the extent of effecting a perfect and continuous blending of images. Nevertheless the fact of habitual ability or failure to maintain binocular vision should constitute a dividing line between strabismic and non-strabismic affections of the ocular muscles. It is to be admitted that in the general literature of "insufficiencies" the dividing line has not been sharply drawn nor

carefully observed. Indeed the term "insufficiency" has, by some writers, been loosely, not to say indiscriminately, used in speaking of well defined strabismic cases. Strabismus may result from insufficiency of certain muscles, but it is to be remembered that an "insufficiency" is not necessarily a strabismus. If these terms may be used in a convertible manner, it is only another reason for the introduction of terms having more precise signification.

Graefe¹ says: "The expression 'strabismus' has a symptomatic signification. It means the inability to unite both visual axes at the same fixed point lying in the common field of vision." And Donders² says: "In strabismus the visual lines do not cross one another in the point it is desired to observe." On the other hand 'insufficiencies,' while they are conditions consistent with binocular vision, may, under certain circumstances, become 'relative strabismus' or strabismus only at certain near points. Thus Donders³ assumes that convergence should occur at 2.5 inches in front of the eyes. Hence should the patient have myopia more than $\frac{1}{2.5}$ there will of necessity result diverging strabismus in reading. Of relative strabismus we shall have more to say in future. In this connection it is only necessary to remind the reader that it is not to be confounded with the more general term strabismus, or absolute strabismus. It becomes, first of all, desirable to find, if possible, some at least approximate indications of the limit of division between the conditions heterophoria and strabismus, or, if I may be permitted a still further extension of terms, between heterophoria and heterotropia. (*Φόρος* a tending; *τροπος* a turning). Such indications of limitation become necessary if we would express exact meaning by the use of our terms. It is needless to say that if slight cases of strabismus are promiscuously classed with heterophoria our observations and records respecting the two conditions must, necessarily, be imperfect and unsatisfactory.

The determination of the existence or absence of habit-

¹ " *Archive f. Ophthalmol.*, iii., i., p. 177.

² " *Accommodation and Refraction of the Eye*," p. 291.

³ *Ibid.*, p. 405.

ual binocular vision is not always devoid of difficulties. In a very large proportion of strabismics the subjects are totally unconscious of double vision, and in another large proportion they are habitually, but not constantly, unconscious. In many strabismic cases the most patient and persistent efforts on the part of the surgeon, perhaps continued through interviews on several days, are required in order to enable the patient to obtain consciousness of diplopia under any circumstances. It is evident, then, that the mere statement of a patient that he does not see double has little value in this connection.

We are, then, to find the means of ascertaining the fact of the presence of diplopia. For this purpose the methods long known to the profession may be, in nearly every case, successfully employed. I shall not here attempt to introduce new methods for reaching this end, but shall suggest some new interpretations of known methods, and endeavor to impress the necessity of a more thorough and systematic employment of those methods than has been indicated by published observations heretofore.

In certain instances in which the deviation of the visual lines is very considerable, yet not sufficient to be manifest to the observer, we may detect the fact of diplopia by the cover test. Unless this test is made with much care it may prove of very little value even in cases of pronounced deviation. While the patient fixes the gaze steadily for a minute or two upon a small object situated at twenty feet distance in the median line, the examiner, seated in such a manner as to obtain a perfect view of the eye to be observed, quickly slips a small card in front of the other eye. If the observed eye is the deviating one, a very slight and quick readjustment of this eye may be seen. This slight movement must not be confounded with a little twitch of the lids which may be seen in some nervous patients at the sudden approach of an object near the eye. Much greater care in observation must be observed than that which is required when, in a case of well marked squint, one places a cover before one eye in order to make a rude estimate of the number of lines of deviation. In a

case of steady binocular vision there will be no readjustment of the eyes when one is thus suddenly covered. This is not the well-known test of introducing a cover to observe whether one eye after a moment deviates outward as in insufficiency of the interni. The test, however, is a gross one, and can only be of service in cases of a considerable degree of deviation. It may be urged that in case of a marked tendency on the part of the visual lines to deviate but with power to maintain binocular vision, the tension upon the various eye-muscles would be different when both eyes are directed to the object from the condition when one eye is covered, and that under such circumstances a readjustment of muscular tension would be made when the cover is interposed before either eye. However correct this line of argument may be, I have not found it verified in practice. In cases in which I am able to detect minute adjustments of this sort, I have almost invariably been able to demonstrate double vision by other means. Hence, while this is a rude test for diplopia, it may, in a certain proportion of cases, be a valuable one.

A very large proportion of those who have habitual unconscious diplopia with such moderate deviations of the eyes as to be scarcely noticed by the observer, will recognize the double images when a prism is introduced in such a manner as to change the relative position of the images, even although it may be in the direction of correcting the diplopia or by slightly elevating or depressing one image. Thus one with unconscious homonymous diplopia may be able instantly to appreciate the position of the two images if the diplopia is partly corrected by a prism, or if one of them is raised above the other by a weak prism with its base down. Experience and judgment will be required to enable one to determine how far the prism is instrumental in inducing and how far in revealing diplopia. The method may prove more valuable in enabling the patient to learn the existence of double images under any circumstances than of determining their habitual presence.

By the ordinary use of the prism which shall remove the images farther from their habitual relation, we have another means of forming a judgment respecting diplopia.

If with a prism, with its base in, we cause conscious diplopia in the manner*already described for detection of hyperphoria, we may determine the manifest deviating tendency from the horizontal plane. If now there were an absolute and uniform degree of such manifest tendency within which habitual blending of images could be assumed and beyond which diplopia could be confidently expected, it would be comparatively easy to settle the question of single or double vision in the vertical direction. I know of no such absolute line of demarkation. Nevertheless we may make some approximation toward a line of limitation. In the orthophoric state the eyes are able to unite images when a prism of 2° to 3° is introduced with its base up or down before one of the eyes. The power to go beyond this is very rare in cases of well-balanced eyes. This, then, marks, approximately, the limit of uniting images in this direction in such a condition. But in hyperphoria, the habitual effort on the part of the patient to force the eyes into proper relations will so develop the strength of the muscles engaged as to enable one to maintain single vision with a deviating tendency of rather more than this. Beyond a manifest deviating tendency of 3° or 4° in this direction,¹ then, we may reasonably expect that the ability to maintain single vision continuously is lost; especially may we infer this if we find associated with this tendency an important deviating tendency in the lateral direction. Thus one who would manifest at twenty feet a tendency of one visual line above the other of more than 3° or 4° and of the lines outward of, say from 6° to 10° , would, with scarcely a doubt, be unable to maintain single vision, although such a person might be able to obtain it for a brief period at a time. I have not met with any case in which, with diplopia under the influence of a horizontal prism, the images deviated from the horizontal plane more than 5° , habitual binocular vision has been maintained. To speak of hyperphoria, or non-strabismic "insufficiency of the inferior recti" of 10° to 15° , is, without doubt

¹ This is not to be confounded with sursumduction, which may reach 9° or more in myopia.

to employ such terms in an extravagant and irrational manner.¹

In a similar manner, if the deviating tendency in the lateral direction is more than the usual ability of the muscles to overcome in the direction opposite to the tendency, a presumption exists that binocular vision is not habitually maintained. The usual power of the abducting muscles in orthophoria is measured by a prism of about 8° or possibly 9° . A deviating tendency of considerably more than this would be inconsistent with single vision, except by the development of the strength of the abducting muscles beyond the physiological standard. Making due allowances for this, it would certainly demand an inordinate and, in the great majority of instances, impossible tension on the part of those muscles to maintain continuous fusion of the images in any case in which the deviating tendency inward should be shown to exceed the usual abducting power. Should it be found in an individual case that with a deviating tendency inwards of rather more than 8° , as shown by a prism with its base down, there should exist an unusual degree of abducting power, the eyes might ordinarily be adjusted for single vision. If, on the other hand, the abducting power should be found to be rather less than the usual standard, making due allowances for all collateral influences, it would be reasonable to assume that binocular vision cannot in such a case be regularly maintained. The proportional power of holding binocular vision at a distance in the deviating tendency outward is less than in the opposite direction; for whereas the fusion-power of a patient with a tendency of the visual lines inward may be equal to or slightly in excess of the usual power of abduction, one with a tendency of the lines outward will see double, at a distance, with a deviating tendency of much less than the

¹ Reports of cases of non-strabismic "insufficiencies" of the superior or inferior recti, for which the patients were required to wear prisms of 12° or 15° or even 20° with the bases up or down, are but grotesque illustrations of prevailing misconceptions in respect to the extent to which "insufficiencies" can exist before reaching the point of strabismus.

Again, in respect to the terms in use: If the ordinary power of the inferior rectus is sufficient to overcome momentarily a prism of 3° , the employment of the term "insufficient" to one which is supposed to habitually overcome a defect equal to 20° prism is evidently an inconsistency.

usual adducting force as measured by prisms. In orthophoria, with or without a little practice, most persons will overcome prisms with their bases out equal to about 50° . But a deviating tendency outward of much less than one half of this amount will be associated with an inability to hold images single during any considerable period of time. Making allowances for rare exceptional cases, my observations have led me to believe that a deviating tendency of 8° or more (at 20 feet) is inconsistent with single seeing. If, in an individual instance, the tendency of the lines is to deviate both in the vertical and in the lateral direction, the task of uniting the lines at the point to be observed becomes still greater. It happens, more frequently than otherwise, that a manifest deviating tendency outward of more than 6° or 20 feet is associated with inability to hold continuous union of the visual lines at that distance and much less at nearer points.

A third method of detecting habitual failure to maintain binocular vision, is by so reversing the ordinary experiences of the visual sense as to bring into consciousness the existence of the extra images which have become by long practice mentally suppressed. This may be accomplished by the well-known device of introducing in front of one of the eyes a glass whose color shall be in strong contrast with the object upon which the gaze is directed. We may use a lighted candle placed at the distance of 20 feet, or more, from the patient, and at which he gazes, in a darkened room, or against a darkened surface. If diplopia exists, it may be manifested when a red glass is placed before one of the eyes. The fact that it is not manifested does not of necessity show that there is single vision, for the habit of a lifetime of suppressing one image may be too strong to be thus easily overcome. In a great many instances of inveterate squint, the difficulty of inducing the patient to recognize double images in this manner is extremely great. It often requires great patience and persistent effort, continued through many interviews on successive days, with the assistance of considerable ingenuity on the part of the surgeon in throwing the image in various directions by

means of prisms while the red glass is maintained in position, before a confession of double images can be obtained. Success will always crown persistent and intelligent effort. When once the patient has learned to apprehend the sensation of double images, little trouble will in general thereafter be experienced in locating them.

The presence of double images at this distance as shown by the colored glass is presumptive of habitual diplopia. Nevertheless, it may be urged that by giving the images different colors there is a modification of the instinctive demand for binocular vision, and the tension is so relaxed as to allow the images to separate. We are then to inquire to what extent this principle may be true. Observations conducted during several years and on a great number of cases have shown that the ability to maintain binocular vision, while a red glass is before one of the eyes, is less ordinarily than in its absence. How much less we will proceed to inquire. If one who has the ability to overcome a prism of 8° , with its base in, places a plain red glass before one of the eyes, his power of abduction will usually reach only 7° . If his power of adduction without the red glass is 50° , he will lose with its presence about the same proportion of his adducting power and will be able to adduct usually not more than about 45° . It thus appears that the influence of the red glass in orthophoria may be rudely estimated as being equal to about one eighth of the abducting or the adducting power. In examinations of those in whom heterophoria exists, the rule appears to hold good. It is to be seen, therefore, that the influence of the red glass in manifesting diplopia is, except within very narrow limits, entirely in the direction of revealing that which exists, rather than permitting diplopia to occur which would otherwise be avoided. Experience leads me to believe that a vertical deviation of a single degree as shown by a red glass is more than a patient will ordinarily overcome without it, and that habitual double vision is the rule when diplopia, as shown with a red glass which demands a prism of more than 1° or 2° for its correction, is found in the lateral direction. Indeed, diplopia with a red glass indicates the extreme limit of single vision without it. It is

to be remembered that in such an examination the patient is on the alert and is making his best efforts at fusion of images. If this statement should appear extreme, I believe it would not so appear after careful examination of the subject. I have found that patients having diplopia with a red glass corrected by a prism of 1° or 2° , will, after their attention has been repeatedly drawn to the phenomenon, become conscious that this is the habitual condition under ordinary circumstances. They may be able to unite images momentarily, but ordinarily the two images are not united. We may summarize these three methods of detecting the presence of habitual diplopia which appear to be most useful as follows:

1. The gaze of the two eyes being directed upon a distant object, the presence of diplopia is shown when the line of vision of one eye being suddenly interrupted by the interposition of a screen, the other eye is seen to make a movement for readjustment.

2. When conscious diplopia is caused by a prism, if the manifest deviating tendency in the vertical direction exceeds 4° , diplopia may be suspected, and the suspicion is made almost a certainty if combined with this there is a lateral deviating tendency of as much as 6° . If the deviating tendency in the lateral direction inward is shown to be more than 10° , or outward more than 8° , it is probable that binocular vision is not maintained.

3. If with a red glass before one eye diplopia is shown in the vertical direction, habitual strabismus exists. If diplopia is shown in a lateral direction strabismus is indicated if a prism of more than 1° or 2° is required to unite the images.

It will thus appear that while we have no absolute boundary between heterophoria and strabismus an approximate limitation may at least be found, and by patient investigation in individual cases we shall be able to make a practical diagnosis between the two conditions. It will hardly be exaggerating to say that diplopia as shown under the influence of a red glass may under almost any circumstances, be regarded as an indication that binocular vision, if obtained

at all, is not habitually maintained. This is perhaps the most practical line of division between strabismus and heterophoria, but it is one often very difficult to find.

I have already¹ called attention to the methods of proceeding in recognizing and treating one of the forms of deviating tendency less than strabismus, hyperphoria. I shall now direct attention to the second in importance, esophoria.

For determining heterophoria, especially hyperphoria, exactitude in the methods of making examinations is of greatest importance. With the view of securing accuracy and of saving time I have devised a phorometer which is here shown.

The instrument consists of the standard A, supported by a tripod. The standard is freely extensible, permitting a ready adjustment for differences in stature of patients. The arm B is grooved, and allows the carriers C and D to rest securely, to slide freely from end to end of the arm, or to be removed at will. At E a spirit-level is attached to the arm, by means of which the horizontal position of the arm can be determined. The semicircular piece at the head of the arm is spirally toothed and is acted upon by the endless screw at F, which imparts to the arm an upward and downward elbow movement. The semicircle is graduated in degrees, and a fine pointer indicates the extent of motion imparted by the screw. By means of the lever G, the screw can be unlocked, allowing the arm to fall to the side of the standard. Of the two prism-carriers one carries two prisms placed horizontal, with their bases in, and of sufficient strength to induce homonymous diplopia. The prism D is placed with its base down and is used for determining lateral tendencies. The rod H carries a tablet I, on one side of which is a small cross and on the other side another cross somewhat larger. The tablet is reversible, and the crosses are used as objects in determining the tendencies in accommodation. The tablet is, when brought into position, one half metre in front of the prism; but by means of a fixation screw it can be brought nearer if desired.

When not in use the rod is parallel with the arm. As has been intimated elsewhere, in the determination of the tenden-

¹ ARCH. OF OPHTHALMOLOGY, vol. xvi., 2, p. 115.

cies of the visual lines much freedom may be given to the position of the head without material effect upon the position of the images, provided the prisms are independent of

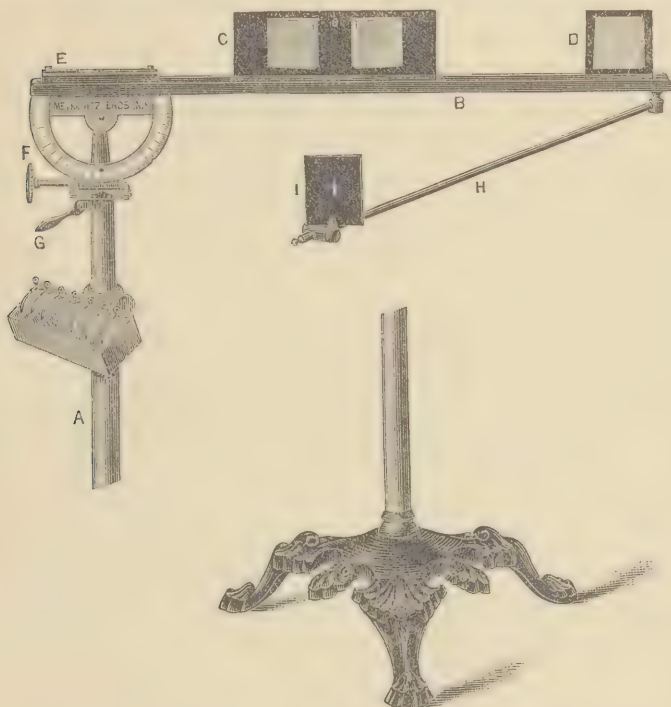


FIG. 1.

the head and somewhat removed from the eyes. This does not hold good in every case, but the exceptions are somewhat rare, and the presence of the exceptional condition can be quickly ascertained.



FIG. 2.

Fig. 2 represents a pair of revolving disks in a carrier adapted to the phorometer; each disk consisting of six prisms with the bases in. The two openings permit the two eyes to see from behind. By pressing upon the milled edge of either disk, prisms of different strength can be brought before the openings. The numerals in the figure show the strength of the various

prisms. This little device I find very convenient and time-saving in the determination of the power of abduction. A series of prisms for adduction is similarly constructed.

IV.—ESOPHORIA.

The method of determining esophoria has been already shown in the former paper. The prism of about 6° is placed before one of the eyes with its base downward or upward, and the patient's gaze is directed toward a lighted candle situated in the median line at the distance of twenty feet. Should the double images now appear exactly in the vertical line, no tendency to deviate in the lateral direction is shown. The test should not, however, be abandoned at this point. While maintaining the vertical prism in position, a very weak prism may now be placed with its base alternately in and out before either eye, when the relation of the double images is again to be observed. Should the images remain in the vertical relation the strongest prism which can thus be interposed without causing a deviation of one or the other image is placed before one of the eyes and the result is recorded as esophoria or exophoria as the case may be of $0^{\circ} < n^{\circ}$. If with the prism, its base down, the images deviate homonymously, esophoria is indicated; exophoria being shown by heteronymous deviation. If, for instance, the prism is placed with its base down before the right eye, the higher image will be that of the right eye. If this image is at the right of the lower one, there is homonymous deviation showing esophoria, but if the higher image should be found at the left of the lower, heteronymous deviation indicating exophoria is shown. In order to measure these deviations with accuracy the prism must be held with its base precisely downward, but we may estimate a deviation by turning the prism a certain number of degrees from the primary position, the strength of the prism and the amount of the turning being known (Graefe).

This test with the vertical prism having been made at the distance of twenty feet, the power of abduction is then to be determined. As stated in the previous paper, the standard of normal abduction should be about 8° . But the fail-

ure to overcome a prism of 8° with its base inward at a distance of twenty feet does not prove that the visual lines actually tend inward, nor does the ability to overcome prisms of higher grades show that these lines tend outward. This restriction of abduction power on the one hand, or its excess on the other, while under ordinary circumstances indicating a tendency inward or outward of the visual axes, in a certain proportion of cases may be the manifestation of some complicating tendency. Hyperphoria, for instance, not unfrequently gives rise to irregular abducting energy. In a case in which hyperphoria of 1° or 2° may be found, esophoria of several degrees may be shown by the test of the vertical prism, while the abducting power may reach 12° or more. On the other hand, the vertical prism may show 2° or 3° of exophoria while the abducting power may be restricted to 4° or 5° which cannot be increased by any adjustment of the prisms to favor the hyperphoria. An operation for hyperphoria will, often but not always, bring these conflicting evidences into harmony. Not every case, however, appears to be thus explained. In a certain number of instances we find restricted abduction with exophoria, or excessive abduction with esophoria, and no other complicating tendency appears to manifest itself even after patient search continued through some months. In general, esophoria is attended with restricted abduction, and as a rule we may accept the fact of inability to overcome a prism of 8° with its base in as indicating an inward tendency of the eyes, unless exophoria is positively shown by the vertical prism.

The test for esophoria having been made at the distance of twenty feet, it should be repeated at the near point. A convenient form of test object is a small cross. The vertical arm of the cross serves to give an idea of the relative position of the images, but does not, like Graefe's dot-and-line test, conceal the deviating tendency by the effort to fuse the double parallel lines. If at the near point the images still deviate homonymously, we have esophoria in accommodation. It not unfrequently occurs that esophoria is shown when the test is made for the distant point, and that exo-

phoria appears by the test in accommodation. Here, as in the case of inconsistencies between the esophoria and abduction tests, hyperphoria is to be suspected. It is likely in this latter case that the influence of the superior muscle in causing the upward tending of one eye gives rise to a swinging movement, which is shown as exophoria in accommodation. I have elsewhere¹ discussed at some length the theory which has been rather generally held, that in these cases "insufficiency" of one set of muscles exists for one distance, and "insufficiency" of the antagonizing set is the condition for another distance. It is to be admitted that all muscles may be weak. It may therefore be admitted that both the external and internal recti may be weak. Are we therefore to assume in every instance, or in any considerable proportion of instances, in which opposite results were found by tests at different points, that when one looks at an object situated at twenty feet there is "insufficiency of the externi," in the sense of too little power to antagonize the interni, while at the near point there is "insufficiency of the interni," in the sense of inability to antagonize the externi? We may find assistance in answering this question, in many instances, by ascertaining the relative power of the opposing muscles in abduction and adduction. Let us take an example which fairly represents a very large class of cases.

Let us suppose that, in our example, a not uncommon one, by the vertical prism we find esophoria 4° , and in accommodation exophoria of 7° or 8° . By abduction the patient overcomes a prism of 8° or even 9° . This abducting force is equal to the ordinary standard, and therefore indicates no weakness of the externi. They can overcome the tension of the interni from the position of equilibrium to an extent as great, or even greater, than the average muscles of their class.

On the other hand there is a power of adduction of 50° . This indicates equally that there is no "weakness" of the interni or failure of power to act when the question is one between these and their immediate opponents. It is true

¹ Transactions International Medical Congress, Washington, 1887.

that there may be a good abducting power coincident with a tendency of the visual lines inward, and the proposition holds good respecting the opposite conditions; but, taken together, the theory that both these opposing sets of muscles are alternately "insufficient" for the other is wholly illogical. We have in our case adequate power of abduction, showing that there is no essential "weakness" of the externi, and full adducting power, proving that the interni are supplied with ordinary strength. With esophoria at distance and in accommodation we might readily and logically conclude that, with full power of each of these opposing sets of muscles, a relative inequality of length of the muscles, or an imperfection of adjustment, would account for the inward tendency; and the same might be said of exophoria at the far and near points under similar circumstances. I hold it absolutely illogical, in view of such facts, to retain the idea of "insufficiency" of both sets of muscles in such cases as that used in the illustration. We must seek for a more reasonable explanation. This, as already stated, I have found in a very considerable proportion of cases in the fact of the existence of hyperphoria. As in the class of cases already cited, in which hyperphoria gives rise to irregularities in the abducting or adducting power, so it is often, if not usually, the complicating element in these contradictory cases in which esophoria is found at one point and exophoria at another. It is not always easy to discover the hyperphoria in these cases. It may elude discovery during several examinations, but the presence of the contradictions under discussion should, I believe, always suggest the existence of hyperphoria. Not until that or some equally important element of disturbance is found should we rest in the belief that we have discovered the actual tendency of the visual lines.

These contradictory conditions include a very large class of cases, and, unless studied from a proper standpoint, a class of cases presenting very great difficulties, both as to diagnosis and treatment.

In a certain number of cases I have been able, after long-continued search, with failure to discover the real muscular

balance, to find the faulty tendencies, after faithfully excluding one of the eyes during some days or weeks. In order to be effectual, the exclusion must be nearly perfect, and the patient must not indulge in the occasional use of both eyes.

The results of this method are to be accepted with great caution, rather as suggestive than conclusive.

It is well known that it is not unusual that one eye, the vision of which is lost by disease or injury, will turn outward. This happens in so large a proportion of cases that it cannot be supposed to be in most instances the result of any original balance of the eyes outward. In like manner, after excluding an eye for one or two weeks, we may find a marked condition of exophoria, which will correct itself after a return to the use of both eyes. Notwithstanding the uncertainty of value of results obtained by the exclusion of one eye, it is a method which in a small proportion of cases has led to information which I have not been able to obtain otherwise.

If we inquire concerning the position which the condition esophoria has occupied in the literature of ophthalmology, we shall find that it has received far less attention than that to which its importance has entitled it. There has existed in the profession a vague and possibly not very fortunate tradition that "insufficiency of the interni" constitutes, excluding strabismus, the important anomaly of the ocular muscles; and this condition has been elevated to an unmerited prominence at the expense of other muscular defects equally if not more deserving of attention than itself. The school of Graefe has, for more than twenty years, dominated in this field of inquiry, and Graefe looked upon the task of adjusting the eyes in the act of reading or working with the hands, as holding a pre-eminent importance. It is no disrespect to the great name of Graefe to assume that this view was and is much too limited. It is not disparaging the consummate abilities or the value of the teachings of this leader in thought to believe that, when all these muscular anomalies have been more fully considered, the condition which principally occupied Graefe's attention in this connec-

tion will be looked upon as that holding the lowest rank of the group in importance.

In Graefe's extensive treatise on muscular asthenopia, his most important reference to "insufficiency of the externi" is included in the following brief paragraph:

"There is another cure for asthenopia based on the storing of the relative range of accommodation. If we weaken by a tenotomy of the internus, the power of action of the latter in a proper manner, so that the proper convergence of the eye in question continues (and this result may be easily reached by tenotomy with the conjunctival suture), then a given degree of convergence is accompanied by a higher degree of accommodation than before. And corresponding with this will be an approach of the relative accommodation to the near point.

"The demand on the energy of accommodation then becomes less. We have produced an effect nearly equal to that which we produce by placing a prism with its edge in, producing voluntary squinting, or as though the patient had squinted for his own relief.

"It is essential to consider, however, in this connection, that by enfeebling the interni beyond a certain measure (even through the use of an adducting prism) we induce slight muscular asthenopia."¹

Graefe says he has resorted to this expedient only twice, and then only in cases where experiments made with prisms (colossal prisms) showed that they were overcome by adduction, giving him the surety that no troublesome insufficiency would result, and where, besides, a very evident movement of the relative range of accommodation had been shown beforehand.

Graefe adds: "In any case the method remains more interesting than practical in comparison with the more peaceful choice of spectacles."

Even here it will be seen that the aim was to secure an approach of the relative range of accommodation to the *absolute near point*; in other words to obviate difficulties arising at the reading distance. It is impossible to form a

¹ *Arch. f. Ophthalm.*, viii., 2, 321.

judgment of the precise condition which was found in these two cases, or the exact result of the operative measure; but it appears certain that Graefe found little encouragement in this method of treatment, since he came to regard it as interesting rather from a theoretical than from a practical point of view.

There is in this little reference to the preponderance of the interni, no solicitude for the equilibrium of the long muscles when the eyes are directed to a distant object, nor for any absolute adjustment of the visual lines at various points; the burden of this paragraph is that with certain efforts at accommodation, especially in hypermetropia, there may occur a slight convergent squint, which influences the relative range of accommodation. This, he says, may be relieved by tenotomy, not graduated to secure equilibrium at the point of least enervation, but enough in the judgment of the operator to prevent insufficiency of the interni at the same time making a higher degree of accommodation necessary than before.

This view cannot in any respect be classed with the view of esophoria which has been advanced in the preceding paper or in this. It is an expedient for the relief of or rather for the exercise of the accommodation, not a remedy for esophoria.

To illustrate the disregard of Graefe for any "insufficiency of the externi," less than positive strabismus, I shall quote at some length, from his great article on asthenopia, his remarks upon the graduation of the extent of the tenotomy in operations for "insufficiency of the interni."¹

"As point of departure (for the graduation of the tenotomy) we must choose according to the *reading distance* of the subject. . . .

"If we should even do a little too much, it would not at the near point cause the least trouble. Strabismus convergens could only occur *if we have exceeded the measure of the total abduction* of which the insufficiency constitutes by far the smaller part. This would be a great mistake. Should we keep within this measure (in over-correction of the insuf-

¹ *Loc. cit.*, p. 349.

ficiency) then the correction would for the near point be reached the more easily, and at most the disadvantage would be the too great reduction of the relative range of accommodation." In discussing further the results of over correction he says :

" There will then become necessary at the distance a tension of the externi. This in itself is, fortunately for the tenotomy, of no consequence ; as, for the act of vision at the distance the same results from continuous strain do not occur. Against this however occurs a real trouble. If in the main, the power of the externi is no longer sufficient for fixation at the distance, strabismus convergens with homonymous diplopia is the result. When, in brief, will this occur ? Necessarily if the definite effect of the tenotomy does not correspond to the extremest abduction for the distance. We therefore find the measure for the tenotomy by ascertaining the strongest prism which can be overcome by divergence for the distance. The linear deflection which corresponds to this prism, we can remove without harm in order to take from the interni, at the near, as much work as possible. After such an adjusted tenotomy, binocular fixation for the distance takes place, of course, with the *greatest strain* for the externi. What is then required of the externi for the distance favors the interni at the near point. If we had taken only the insufficiency for the distance and not the total abduction, then we would have unnecessarily sacrificed to an illusory advantage for the distance (tension of equilibrium) a part of the real advantage for the near."

Respecting the above, Graefe says : " I have here spoken of the permanent effect. The temporary one may be even considerably greater. We may exceed without harm the abduction for the distance by from two thirds to three fourths of a line, so that there will result, in the median line for the distance, homonymous double images which are united by a minimum prism of 10° ."

Graefe adds that he has often operated to such an extent that prisms of from 15° to 20° were required, not to correct the insufficiency of the externi produced, but to unite the

double images resulting from the temporary converging strabismus. In his illustration of the different grades of the affection and their treatment he says: "Let a second patient have at the near point insufficiency (prism) 16° , at the distance insufficiency (prism) 6° with abduction (prism) 16° . We can take from him by tenotomy the full insufficiency for the near, as that is equal to the abduction at the distance; thus he will now be just able to fix for the distance, *though with greatest possible strain of his abducting power, to which, as we have already found, there is no objection.*" Even when the abducting power is no more than 4° Graefe still recommends weakening of the externi to the point of complete abolition of the abducting power.

It will thus be seen that any insufficiency of the externi short of actual converging strabismus was regarded by Graefe as a matter of no consequence, provided he could secure less of tension at the reading distance.

Indeed, herein is found a radical difference between the system taught by Graefe and that which has been pointed out in these papers, as well as in my former writings. Graefe sought to adjust the eyes for the near point at any sacrifice of the relations of the visual lines at greater distances short of absolute diplopia. His examinations at a distance were not in the interest of actual equilibrium of the ocular muscles, but in respect mainly to the question of how much could be sacrificed in the effort to establish binocular vision at the reading point. In the system here presented, perfect equilibrium, in all respects, in vertical as well as lateral directions, and at the point of greatest relaxation both of the directing and accommodating muscles, is the end to be attained, in the expectation that, this being established, easy adjustments will result at all points, near and distant.

The great majority of text-books completely ignore non-strabismic insufficiencies of the externi, muscular asthenopia and insufficiency of the interni being synonymous terms. Thus Soelberg Wells¹ devotes a section to the discussion of "Muscular Asthenopia (Insufficiency of the Interni)."

¹ "Diseases of the Eye."

His tests for the affection are all made at the near point, the principal one being the dot and line of Graefe. In determining abduction and adduction he removes the object to a distance of from six to ten feet.

Galezowski¹ discusses "Latent Divergent Strabismus, or Muscular Asthenopia," and says that muscular asthenopia is due to "insufficient contractile force of the internal recti." His only test is the dot and line, and made at a distance of fifteen centimetres from the eyes. The third edition of this work, very recently issued (1888), advances no change of view.

Landolt² defines muscular asthenopia as "insufficiency of the internal recti muscles." In his later writings³ he lays much stress upon insufficiency of the converging force, but does not consider the effect of insufficient diverging power or of insufficiency of the externi.

Stelwag⁴ says: "The immediate cause (of asthenopia) is *always* the overburdening of the muscle of accommodation, or of the *internal recti*, as the case may be." In a single sentence in one edition there appears a recognition of "insufficiency of the externi" as a possible cause of asthenopia.

Schweigger, in his work on "Squint,"⁵ devotes a chapter to "Muscular Asthenopia," which he attributes solely to insufficiency of the interni.

Without further reference it may be said that these representative works fairly indicate the importance attached to the condition we are now discussing, and that they indicate that no significance was attached to the condition, except in a single instance, where a brief reference agrees with Graefe's view that an insufficiency at the point of strabismus might become an element of disturbance of relative accommodation. Even this limited and wholly inadequate

¹ "Maladies des Yeux" (first edition), pp. 739 and 789.

² "Manual of Examinations of the Eyes"; translated by Burnett.

³ "L'Amplitude de Convergence," 1885; "Insufficiency of the Power of Convergence," 1886; "Refraction and Accommodation of the Eye," 1886.

⁴ "Diseases of the Eyes."

⁵ London translation, 1887.

view was, by almost universal consent, relegated to the realm of the impractical.

I have seen nothing in the literature of ophthalmology, until attention had been called to the subject in my own writings, which, in any degree, controverts this opinion of Graefe. It is true that there occur, in great rarity, references to the condition of insufficiency of the externi; but, as the cases which have been cited as illustrations are only moderate cases of strabismus, such as under the definition of esophoria given above would be excluded, it can scarcely be said that the subject has received any attention at all. Cases in which diplopia is manifested at the distance of twenty feet, upon the introduction of a colored glass before one of the eyes, even should that diplopia not exceed 2° or 3° can hardly, by any process of logic, be regarded as included within the limits of esophoria. And the fact of the presence of diplopia, even in smallest degree, is a fact presumptive of habitual failure to unite images, for, during an examination, with the attention of the patient closely fixed upon the object, he is likely to make his best efforts, and if he fails in this, it is highly probable that he does not succeed under ordinary circumstances.

In a paper on *Oculo-neural reflex irritation* read at the International Medical Congress at London, August, 1881, a case was reported in which tenotomy of one of the internal recti muscles had been made in which an insufficiency of the externi of only 2° at twenty feet existed. The patient immediately after the operation had no insufficiency, and was able to overcome a prism of 10° by adduction. The patient had been an epileptic, and an entire relief from epileptic seizures had followed the operation. I may add that relief continues to the present time. At the same Congress in another paper, a similar operation for a similar condition was reported, in which the most marked relief had followed in a case of nervous disease. In an essay presented to the Royal Academy of Medicine of Belgium, December, 1883, I reported having at that time performed operations for this defect in three hundred and fifteen cases, and many of those cases were given in detail. Up to the present time I have

performed this operation for the relief of esophoria in more than two thousand cases.

In respect to the clinical importance of esophoria, which occurs in the proportion of more than three to one of exophoria, it plays a much more important role than the latter as a predisposing cause to a variety of neuroses; and, as the immediate cause of asthenopia and kindred affections about the eyes, it is an element of great disturbance. It is probably true that in an individual case of exophoria, the strain in adjusting the eyes may be more immediately expressed in the orbit in the form of localized pain of the over-strained muscles than in an average case of esophoria of equal extent. The reactions of esophoria are likely to be more distant. Thus, the patient affected with exophoria may, after an hour spent in reading, suffer from pain in and immediately about the orbit. On the other hand, the patient affected with esophoria, after attending church or the opera, or after visiting a picture gallery, where the eyes have been directed during a considerable time at a distant point, and in such position as to hold the visual lines in parallelism, the result is quite likely to be a universal malaise, with pain at the back of the head and in the upper part of the neck, and possibly, if the patient is not strong, a sense of illness all the following day.

Reviewing a large experience in comparing these two conditions, I find that the general or distant reactions from esophoria are far more frequent and significant than those of exophoria, and that the local pains, while possibly absent in a greater proportion of cases, are still of great prevalence and of a more persistent character when existing.

The grade of the deviating tendency does not always mark the extent of irritation resulting from it. Indeed, these anomalies of the ocular muscles sometimes result in less serious reactions when extreme than when moderate. Thus, in a case of esophoria or exophoria of 2° or 3° the defect is sometimes a source of greater irritation than one on the verge of strabismus, of 8° or 9° ; because in the first instance binocular vision is constant, or nearly so, although effected by strenuous effort. In the second case the image

of one eye is often suppressed, and the eye is permitted to drift away from the physiological companionship of its fellow; thus affording a rest of one kind at the expense of another sort of nervous perplexity. This principle is sometimes illustrated after operations in cases of complicated strabismus. If a patient who has, for instance, a widely divergent strabismus with moderate deviation of one eye above the other, is subjected to an operation for the correction of the divergence, the patient at once becomes annoyingly conscious of double vision, and this consciousness remains until the correction of the vertical deviation is made. Of course such a patient had never been free from double vision previous to the first operation, but the consciousness and annoyance only arose when the double images were brought into very close proximity.

It is not an uncommon circumstance that, of two members of the same family having similar tendencies of heterophoria, the member manifesting the lesser defect is often the one to experience the most serious nervous reactions. It does not follow that the latter of the two mentioned has actually less anomalous tendency than the other, but such a one by a more strenuous effort may conceal what the other reveals, and by this very effort induce the nervous disturbance.

It is not to be supposed that because esophoria is more often than exophoria the predisposing cause of distant disturbances, it is therefore not a notable cause of asthenopia. Of a large class of cases which go from one oculist to another in the hope of relief from some new treatment and submit to an almost endless change of spectacles with little if any advantage, a very considerable number are victims of very slight grades of esophoria. They gain no relief until this too much neglected anomaly receives due attention, when their asthenopic symptoms disappear.

To the ordinary phenomena of asthenopia may be added the following symptoms which are prominent among the local indications of esophoria.

In a certain proportion of cases, especially those in which esophoria approaches the extreme limits to which binocular

vision can be maintained, the accommodation is suppressed in order to avoid too excessive convergence at the near point; the patient preferring an imperfect accommodation, and hence an indistinct image, to a more perfect accommodation with loss of perfect union of the images of the two eyes. The habitual suppression results in weakened power of accommodation, which is often associated with a widely dilated pupil. Even after an entirely successful operation for the relief of the esophoria, the accommodation sometimes remains enfeebled and the pupil sluggish and expanded for many months, continuing the symptoms of asthenopia and headache.

In esophoria, especially when combined with hyperphoria, one of the very unpleasant symptoms not unfrequently met with is the annoyance experienced by the patient in constantly seeing the nose. This may appear a trivial symptom, yet it is described by those subject to it as a most vexatious phenomenon. Many patients declare that they can bear the pain of the head and back resulting from the muscular condition better than they can endure the never ceasing annoyance of seeing the nose.

In similar conditions patients not unfrequently complain of seeing a black spot in the centre of the field of vision. Thus while reading, a black spot is frequently present at or near the part of the page at which the reader is looking, causing annoyance and confusion. This black spot would appear to result from a temporary failure of the visual lines to unite at the desired point, permitting one eye to float inward to an extent that the blind spot appears at the reading point.

The effect of esophoria on vision, while, in the lesser degrees, not so pronounced as that which has been shown to result from slight grades of hyperphoria, is, in moderately high degrees, of a most unequivocal character.

Amblyopia has been shown to be rather the rule than the exception in hyperphoria. In esophoria, amblyopia is the rule when the deviating tendency exceeds 2° . The visual condition of 100 consecutive uncomplicated cases of esophoria was examined with the following result: no case

in which hyperphoria of 1° existed, or in which hypermetropia or myopia exceeded 3.00 D, or in which astigmatism of more than 1.50 D was found, nor any case of disease or injury being admitted to the list.

In these 100 cases the average vision of the 200 eyes (no case being recorded at more than $\frac{20}{20}$) was equal to a small fraction less than $\frac{20}{20}$. It thus appears that in slight grades of esophoria the tendency has little if any influence upon the state of vision.

In 100 other cases in which the degree of esophoria was not less than 3° or more than 8° , the vision is shown in the following table. In these cases, as in the first series, all complicating deviating tendencies were excluded, and the restrictions in regard to disease or injury and in regard to refraction were the same. The table shows the number of best eyes and of worst eyes having certain grades of vision from $\frac{20}{20}$ to $\frac{20}{100}$. In each case one eye is reckoned as best and the other worst, even when both were of similar grade.

TABLE :

Vision.	Best Eyes.	Worst Eyes.
$\frac{20}{20}$. . .	36 . . .	28
$\frac{20}{30}$. . .	46 . . .	39
$\frac{20}{40}$. . .	15 . . .	23
$\frac{20}{50}$. . .	2 . . .	4
$\frac{20}{70}$. . .	1 . . .	2
$\frac{20}{100}$ to $\frac{20}{100}$. . .	— . . .	4
	100	100

It appears from the above table that the average vision in esophoria of more than 3° is materially reduced, and that :

The average vision of 100 best eyes is about $\frac{20}{27}$.

The average vision of 100 worst eyes is about $\frac{30}{80}$ or $\frac{20}{85}$. In other words, the average loss of visual power of the 100 best eyes is nearly $\frac{1}{3}$, while the average loss of the 100 worst eyes is nearly $\frac{1}{2}$.

It is only reasonable to suppose that a condition which must of necessity act as a constant cause of nervous perplexity and irritation, should result in inducing a state of hyperæmia or of altered nutrition of the parts supplied

to a certain extent by branches of the same nerves which supply the imperfectly balanced muscles. It could scarcely happen that an irritative cause so prolonged in its existence and so efficient in inducing functional disturbances should fail to be a frequent cause of such perverted nervous influences upon the eyes themselves or their immediate surroundings as to promote pathological changes of divers forms. Hence, for instance, it is not a surprising fact that one who, during a lifetime, has contended with the irritating influences of heterophoria, should at length find that the nutrition of the crystalline lens has suffered degenerative changes, or that even the tunics of the eye should be affected unfavorably. This view of the possible or probable origin of many affections of the eye is not one to be regarded with disdain or treated as the outgrowth of extreme views. Diseases do not usually occur spontaneously. They are the result of laws, and it is idle for us to speak of cataract or corneal ulcer or of various other affections simply as accidental or providential visitations; and a fallacy to talk about "constitutional causes," when we mean that we do not know. A known cause which may induce perverted nervous action is of more practical consequence than a volume of profound ambiguity. Many years ago I called attention to the influence of refractive anomalies as predisposing causes of corneal ulcers,¹ and I have since had the satisfaction of observing that several close observers have arrived at similar conclusions. I cannot doubt that refractive and muscular lesions are very largely effective in the causation of various eye affections both internal and external.

True there are certain well-known general physical contaminations which are manifested as local affections; but even in the presence of these sources of unmitigated evil we may learn that the localizing of the virulence is favored by a damaged or enfeebled state of the nerves supplying the affected part.

Hence in many chronic and obdurate affections of the eye we may look upon the conditions of anomalies of refraction and of the eye muscles as probable sources of mischief.

¹ Transactions International Congress, Philadelphia, 1876.

Should a case of incipient idiopathic cataract present itself, and should I find associated with it pronounced anomalies of the eye muscles, I would most surely advocate the rational treatment for these conditions. Would the cataract stop? Perhaps not. But in many cases within my experience it has stopped. It would be doing a rational and intelligent act to relieve the patient from a source of irritation which might affect the nutrition of the lens unfavorably. The arrest of the complaint might not follow, but the surgeon has made no mistake if he performs his work well, and he has a reasonable expectation that the pathological process may be arrested.

The distant effects of esophoria include a vast number of disturbances, localized or more general. It is unnecessary to speak of these in detail. Prominent among them are vertigo, nausea, insomnia, headache, and backache. Many of these distant effects are discussed at length in my work on "*Functional Nervous Diseases*."

A large class of people who from year to year are supposed to suffer from "malaria," "biliousness," "nervous prostration," "dyspepsia," and similar neurasthenic conditions are simply paying the penalty of uncorrected esophoria. The effect of this and other forms of heterophoria are frequently seen in their influence upon the physical functions. Chronic constipation, disurea, and dysmenorrhœa are not infrequent results of the reflex irritation from heterophoria.

Treatment of Esophoria.

While recognizing esophoria as an important anomaly, there may reasonably be a diversity of view respecting the manner in which it is to be treated and the extent to which treatment should be carried.

In the first place it may be held that in case of asthenopia or of more general nervous disturbance from esophoria, treatment directed to the improvement of the general tone of the patient by means, of tonics, rest or change, by the local stimulation by electricity, or other familiar means, the nervous manifestations may disappear. To a certain extent this may be true; but what then disappears is not the disadvantageous condition but the temporary results.

The defect remains to renew its unfavorable influence whenever, as the result of a lowering of nervous vigor through prolonged fatigue or anxiety, or through sudden shock or exposure to unfavorable influences, there remains too little nervous energy to accomplish the ordinary requirements of the individual and to correct the defective muscular tendency. It follows that the relief by the methods named can only be temporary and is by no means radical.

But it may also be questioned whether esophoria of slight degree should be subject to treatment.

I have already pointed out the fact that the reactions from these muscular anomalies are not in proportion to their extent. A condition of esophoria of 1° or 2° may induce a train of nervous symptoms of great importance, and which in spite of any treatment short of relief to the defect itself may continue during many years. I am convinced that any deviating tendency in this direction is a physical disadvantage and should be removed.

But is it proper to interfere with such a condition on purely theoretical grounds, although the subject of the defect may not experience any conscious discomfort from it? At present it is a question to be settled by the individual judgment of those most interested. We should, however, bear in mind the fact that esophoria is a condition which demands constant correction by the person subject to it. This correction demands an expenditure of nervous energy which would not, in the absence of esophoria, other things being equal, be required. In other words, esophoria causes a waste of nervous power. When we recall the continuous nature of this waste and the amount of force at times required to regulate the action of the eye muscles, it will hardly appear extravagant if we assume that even should the subject of esophoria, by virtue of an abundant supply of nervous energy or as the result of favoring circumstances, suffer no conscious annoyance, he is nevertheless deprived of a certain amount of nervous ability which he might otherwise possess, and however capable such a one may be, his powers are still less efficacious than they might be in the absence of an enervating cause. This is a practical fact already demonstrated in an abundant number of cases.

By only two methods can we hope to relieve the tension and perplexity of esophoria. They are by the use of prisms and by tenotomy. I have elsewhere expressed my views respecting the value of prisms in the treatment of heterophoria. They are invaluable as aids in determining the condition of the ocular muscles, not only to be used in the consulting room, but to be worn temporarily by the patient. It is my custom to keep on hand a large number of spectacle frames of uniform size, and a quantity of plain prism glasses of 1° , 2° , and 3° , which can be, without loss of time, slipped into the frames. With these I am able in a moment to arrange temporary prisms for a patient, who may be required to wear them for a few days or a few weeks as the case may be, and such changes in strength of prism can be readily made as circumstances may require. In this way latent heterophoria may become manifest. When no longer needed the glasses are returned and may be used for another. After all that can be done by the wearing of prisms and by gymnastic training by prisms in the hands of the surgeon, there remains *the most effectual and satisfactory treatment, graduated tenotomy.*

It is a matter of the greatest importance to determine precisely under what conditions tenotomy is permissible or advisable and to what extent it may be carried.

For the purpose of greater clearness I will divide the cases into two classes:

1. Simple cases in which the indications are not contradictory.
2. Complicated cases in which the evidences are inconsistent, or in which evidences in the same direction are manifestly disproportionate.

Of the first class we may meet with a variety of conditions.

a. There may by the vertical prism be found no manifest esophoria, nor is hyperphoria shown by the horizontal prism, but *the abduction power is less than the standard.* If, after training the abducting muscles by requiring them to overcome gradually increasing prisms a few minutes at a time for several days, the abducting power remains too low,

a weak prism may be worn for a few days with its base out. If even then there is no manifest esophoria and the abducting power is the same or less, and if there is no exophoria in accommodation, an operation is undoubtedly permissible.

b. Less difficult is it to decide if with the restrictions of abduction there is manifest esophoria, provided that the limitation of abduction and the degree of esophoria are proportioned. Should the restriction of abduction be only 1° or 2° while the manifest esophoria should amount to a considerable greater number of degrees, there would remain a doubt whether a complication does not exist, and operation would only be warranted after repeated investigations.

The second class may present far greater difficulties. Here we may have :

a. Restricted abduction with exophoria as shown by the vertical prism.

b. Restricted abduction with or without exophoria but with exophoria in accommodation.

c. Full or excessive power of abduction with esophoria.

All these conditions are liable to be the result of a complicating tension, most frequently of hyperphoria, and whether manifest or latent great caution should be observed before operating, to determine the presence and nature of the complicating element. Should hyperphoria be found, it should always receive attention first.

After the correction of hyperphoria the case may be greatly simplified.

Should hyperphoria be found in a case in which the indications of esophoria are uniform, we should first correct the hyperphoria unless esophoria is of so pronounced a degree as to render it possible that the hyperphoric tendency is a result of the tension of lateral muscles. In such cases an operation for the partial correction of esophoria may be first made.

Very marked and salutary results often follow a tenotomy in case of esophoria of 1° or 2° or in case of abduction of only 5° or 6° . For cases illustrating this the reader is referred to some of my previous works.¹

¹ See especially "Functional Nervous Diseases." D. Appleton & Co., 1887.

The method of operating in heterophoria has been described in the former paper.¹ Since writing that paper the method has been still further modified, and I shall here only refer to the modified steps in the operation.

In making the incision through the conjunctiva the smallest possible opening is made, precisely over the centre of the insertion of the tendon. The opening should be less than $\frac{1}{2}$ millimetre in extent. Then the blades of the scissors are introduced with greatest care one on the scleral and the other on the conjunctival side of the tendon, when they are insinuated toward the border, then pressed strongly against the insertion of the tendon.

In order to permit the blades to be introduced in this small wound and to be carried properly into position for cutting the tendon, they have been modified in an important manner. As now made the blades are quite thick and



Subconjunctival Tenotomy Scissors.

strong until within about one third of an inch from the extremity, when they become suddenly very slender, the two united being less than the size of No. 1 Bowman's probe. The points, although so extremely delicate, are perfectly strong and "walk and talk" together in the most perfect manner. There is no catching or failure to cut under any circumstances.

In operating for esophoria a certain allowance is to be made for the contraction which occurs in the process of healing.

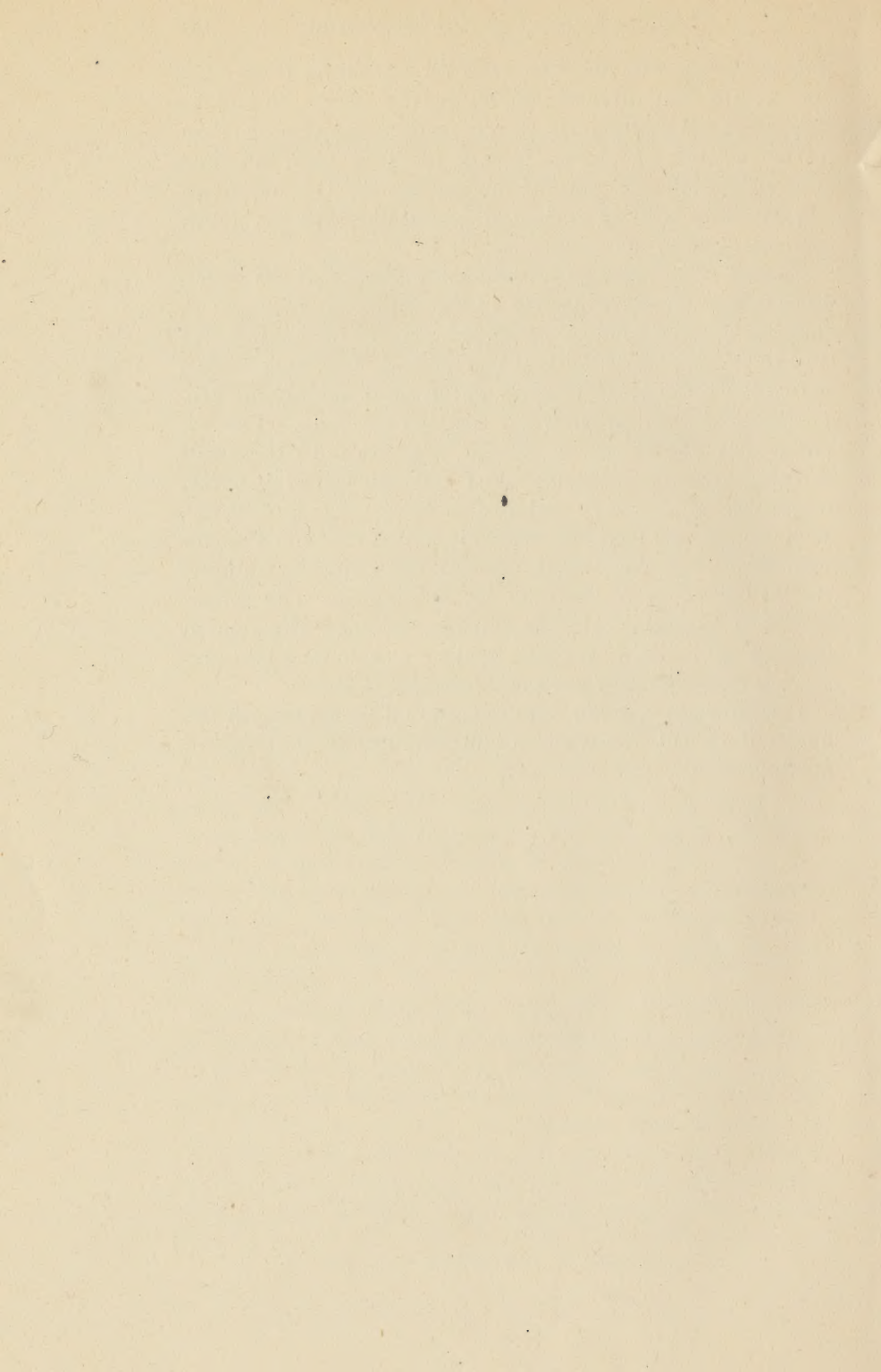
I have found it advisable to allow not more than 1° or 2° exophoria immediately after the operation, with abduction of 11° or at most of 12° . If we allow a greater degree of exophoria or of abduction, we are open to risk of permanent exophoria. Exophoria of 1° or 2° on the day following the operation is liable to progressive increase, and should

¹ ARCHIVES OF OPHTHALMOLOGY, June, 1887.

the abduction remain in excess with exophoria 1° or more on the next day after the operation, the excess should be corrected. An exophoria 1° or 2° , with abduction of 11° or 12° at the time of operation, very rarely, if ever, shows an over-correction after the first few hours. On the following day after such an operation, we should hope for abduction of 8° with no esophoria.

Should it be required to reduce the extent of the operation, it can be accomplished in the following manner: A delicate Tyrell's hook is introduced beneath the conjunctiva and the divided extremity of the tendon. The hook is then turned with its point forward and pressed against the central part of the tendon when traction is made. The extreme cut border of the tendon is drawn into the small opening of the conjunctiva when a needle carrying a No. 000000 silk thread is passed as near to the edge as possible. It is then passed into the sub-conjunctival tissue at the corneal side of the wound and outward, including the conjunctiva to the extent of less than one millimetre. The thread is tied so as to graduate the tension, bringing the tendon forward sufficiently to guard against exophoria while preserving the required relaxation.

This procedure, when required, should be made with the finest of thread and with the most extreme delicacy of manipulation.





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